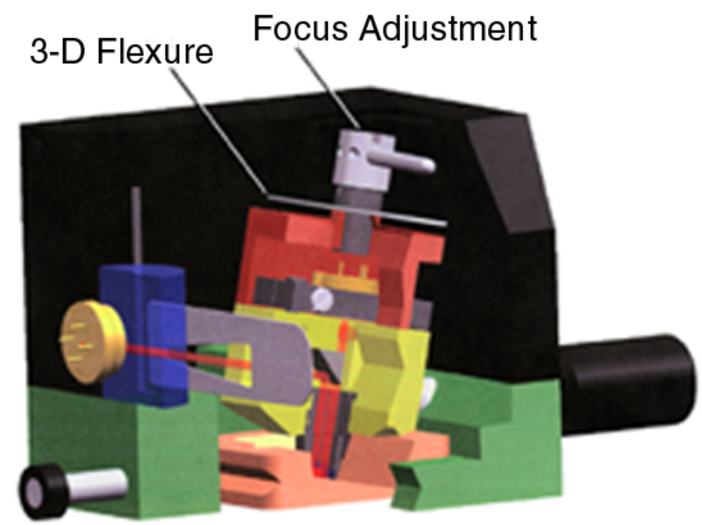
The Next Generation Atomic Force Microscope

Paul Hansma, UCSB, DMR 9988640

The United States has maintained technical leadership in Scanning Probe Microscopy for approximately 15 years based, in large part, on prototypes developed with NSF DMR support. Now, however, the first generation instruments are becoming dated. Fortunately, however, second generation instruments, based on new prototypes developed with the support of the current grant, are now being commercialized by an American company: the Digital Instruments Division of Veeco.

This figure shows some of the novel features of the newest prototype developed with NSF DMR support. The first commercial version of a small cantilever Atomic Force Microscope will be based on this prototype. The 3-D flexure allows the focused beam spot to be positioned with micron accuracy both in the plane of the cantilever and perpendicular to it. The focus adjustment does this perpendicular positioning. Two fine pitched screws push the optics block for positioning in the plane of the cantilever.



Other novel features include a carbon composite shell for high mechanical rigidity and a new optical design that is much more compact than earlier versions. A provisional patent application citing NSF DMR support has been filed with the U.S. patent office.

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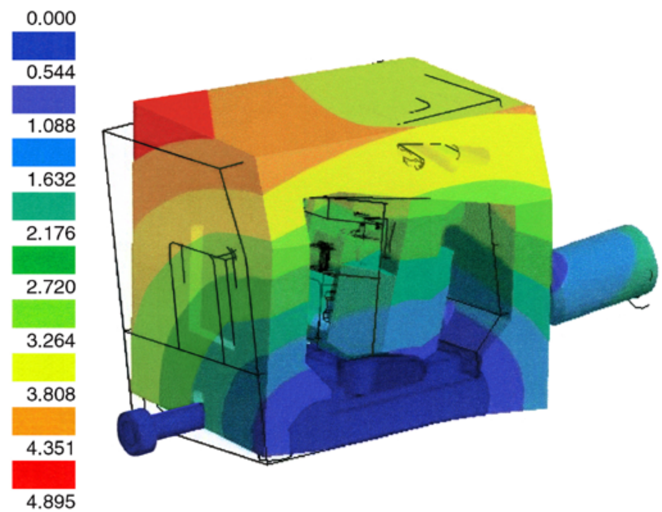
One of the undergraduate students and one of the graduate students supported under this grant learned how to do finite element analysis and used this knowledge to optimize the rigidity of the next generation Atomic Force Microscope.

This use of finite element analysis and computer-design moves the design of Scanning Probe Microscopes to the next level and trains students to produce much more sophisticated instruments.



This figure shows a finite element analysis plot of the lowest vibrational frequency of this head, 1250 Hz. Red indicates the region of the microscope that moves the most in this vibrational mode. Purple indicates the portion that moves the least. The wire frame is an exaggerated version of the motion. This lowest vibrational frequency is higher than the 800 to 900 Hz of current commercial instruments.